

What is claimed is:

1. A method comprising:
 - receiving a time sequence of magnetic resonance images for a region, each image having a plurality of pixels and wherein a contrast agent is introduced into the region at an introduction time occurring during the time sequence;
 - selecting a first subset of at least one image from the time sequence of magnetic resonance images, each image of the first subset corresponding to a time prior to the introduction time;
 - selecting a second subset of at least two images from the time sequence of magnetic resonance images, each image of the second subset corresponding to a time subsequent to the introduction time;
 - calculating a mask image as a function of corresponding pixels of each image of the first subset;
 - calculating an arterial image as a function of corresponding pixels of each image of the second subset; and
 - generating a composite image as a function of a difference between each pixel of the mask image and a corresponding pixel of the arterial image.
2. The method of claim 1 wherein receiving the time sequence includes receiving images having pixels represented by complex numbers.
3. The method of claim 1 wherein generating the composite image includes calculating a magnitude for each pixel.
4. The method of claim 1 further including displaying the composite image.
5. The method of claim 1 further including storing the composite image.

6. The method of claim 1 wherein the first subset includes at least two images and wherein calculating the mask image includes calculating an average pixel as a function of corresponding pixels of the at least two images.
7. The method of claim 1 further comprising displaying, on a computer monitor, at least one image of the time sequence of magnetic resonance images.
8. The method of claim 7 wherein selecting includes receiving a user entered selection corresponding to a displayed image.
9. The method of claim 8 further including displaying the mask image as a function of the user entered selection.
10. The method of claim 9 wherein displaying the mask image includes displaying the mask image in real time relative to the user entered selection.
11. The method of claim 8 further including displaying the arterial image as a function of the user entered selection.
12. The method of claim 11 wherein displaying the arterial image includes displaying the arterial image in real time relative to the user entered selection.
13. The method of claim 8 wherein displaying the composite image includes displaying the composite image in real time relative to the user entered selection.
14. The method of claim 7 further including distinguishing, on the computer monitor, each image of the first subset.

15. The method of claim 7 further including distinguishing, on the computer monitor, each image of the second subset.
16. The method of claim 7 further including displaying at least one image editing function corresponding to at least one image.
17. The method of claim 16 wherein displaying at least one image editing function includes displaying, at least one of any combination, of a magnification function, a cropping function, a brightness function and a contrast function.
18. The method of claim 1 wherein selecting includes executing a processor controlled selection routine.
19. The method of claim 1 further including determining the introduction time.
20. The method of claim 19 wherein determining the introduction time includes:
 - calculating a quality measure for each image of the time sequence of magnetic resonance images; and
 - selecting the introduction time as a function of a rate of change of the quality measure for each image relative to the time sequence.
21. The method of claim 19 wherein determining the introduction time includes iteratively calculating a composite image having a maximum quality measure wherein the quality measure is a function of relative intensity of selected pixels in a particular row of the composite image.
22. A method comprising:
 - receiving a magnetic resonance image having a plurality of rows of pixels, each pixel having an intensity;

selecting a subset of rows from the plurality of rows;
for each row of the subset of rows, identifying foreground pixels as having an intensity greater than a first predetermined threshold;
for each row of the subset of rows, identifying background pixels as having an intensity less than a second predetermined threshold; and
calculating a quality measure as a function of a difference of an average intensity of each foreground pixel and an average intensity of each background pixel.

23. The method of claim 22 wherein at least one of any combination of the first predetermined threshold and the second predetermined threshold is a function of a percentile for each row.

24. The method of claim 22 wherein the subset of rows excludes at least one row of the plurality of rows.

25. The method of claim 22 wherein calculating the quality measure includes:
calculating a first partial measure as a function of a difference of an average intensity of each foreground pixel and an average intensity of each background pixel for those foreground pixels and background pixels in a first predetermined region of the image;

calculating a second partial measure as a function of a difference of an average intensity of each foreground pixel and an average intensity of each background pixel for those foreground pixels and background pixels in a second predetermined region of the image; and

quantifying the quality measure as a function of the first partial measure and the second partial measure;

wherein the first predetermined region is exclusive of the second predetermined region.

26. The method of claim 25 wherein the first predetermined region includes a first half of the image and the second predetermined region includes a second half of the image.

27. The method of claim 25 wherein quantifying the quality measure includes summing the first partial measure and the second partial measure.

28. The method of claim 22 wherein selecting the subset of rows includes receiving a user selection.

29. A method for identifying a contrast arrival image in a time sequence of magnetic resonance images:

- calculating a quality measure for each image of the time sequence of magnetic resonance images; and

- selecting the contrast arrival image as a function of a rate of change of the quality measure for each image relative to the time sequence.

30. The method of claim 29 wherein selecting includes determining a peak increase in the rate of change.

31. A method comprising:

- receiving a time differentiated series of magnetic resonance images for a region;

- selecting a subset of images from the time differentiated series, the subset including at least two images;

- generating a mask as a function of a sum of the subset of images; and

- generating a difference image as a function of a difference between the mask and a selected image of the time differentiated series.

32. The method of claim 31 wherein generating the mask includes calculating an average.

33. The method of claim 31 further including displaying the difference image.

34. The method of claim 31 wherein selecting the subset of images includes selecting images having motion artifacts less than a predetermined criteria.

35. The method of claim 31 further including detecting an arrival time of a bolus in the region.

36. The method of claim 35 wherein receiving the time differentiated series includes receiving at least one image at a time prior to the arrival time.

37. The method of claim 35 wherein receiving the time differentiated series includes receiving at least one image at a time subsequent to the arrival time.

38. The method of claim 35 wherein selecting the subset of images includes selecting images occurring at a time prior to the arrival time.

39. The method of claim 35 wherein generating the difference image includes identifying the selected image and wherein the selected image occurs subsequent to the arrival time.

40. A method comprising:

receiving a time differentiated series of magnetic resonance images for a particular region, each image including a plurality of pixels and each pixel having a pixel value at a pixel location;

for each pixel location, determining a composite pixel value as a function of each pixel value for each image in the time differentiated series; and
generating a composite image as a function of each composite pixel.

41. The method of claim 40 wherein determining the composite pixel value includes calculating a standard deviation.

42. The method of claim 41 wherein determining the composite pixel value includes filtering pixel values.

43. The method of claim 40 wherein determining the composite pixel value includes enhancing contrast between adjacent pixel locations.

44. The method of claim 40 wherein generating the composite image includes increasing the composite pixel value for those pixel locations having a standard deviation of pixel values greater than a predetermined value.

45. A system comprising:
a processor adapted to receive a time sequence of magnetic resonance images for a region, each image having a plurality of pixels and wherein arrival of a contrast agent into the region at an introduction time occurs during the time sequence;

a selector module for selecting a first subset of at least one image from the time sequence of magnetic resonance images, each image of the first subset corresponding to a time prior to the introduction time and for selecting a second subset of at least two images from the time sequence of magnetic resonance images, each image of the second subset corresponding to a time subsequent to the introduction time; and

wherein the processor includes instructions to calculate a mask image as a function of corresponding pixels of each image of the first subset and to calculate an arterial image as a function of corresponding pixels of each image of the second subset; and

wherein the processor includes instructions to generate a composite image as a function of a difference between each pixel of the mask image and a corresponding pixel of the arterial image.

46. The system of claim 45 further including a monitor coupled to the processor and adapted to display the composite image.

47. The system of claim 45 further including a user operable controller coupled to the selector module wherein the user operable controller is adapted to select at least one of any combination of the first subset and the second subset.

48. The system of claim 47 wherein the user operable controller includes a mouse.

49. The system of claim 45 further including a memory coupled to the processor and adapted to store data corresponding to the time sequence of magnetic resonance images.

50. A device comprising:
a processor adapted to receive a magnetic resonance image having a plurality of rows of pixels, each pixel having an intensity;
a selector module coupled to the processor and adapted to select a subset of rows from the plurality of rows;

a foreground identifier coupled to the processor and adapted to identify foreground pixels in each row of the subset of rows, wherein each foreground pixel has an intensity greater than a first predetermined threshold;

a background identifier coupled to the processor and adapted to identify background pixels in each row of the subset of rows, wherein each background pixel has an intensity less than a second predetermined threshold; and

wherein the processor is adapted to execute instructions to calculate a quality measure as a function of a difference of an average intensity of each foreground pixel and an average intensity of each background pixel.

51. The device of claim 50 wherein at least one of any combination of the foreground identifier and the background identifier includes a user operable pointing device.

52. The device of claim 50 further including a memory coupled to the processor and adapted to store the quality measure.